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(54) **PIPERAZINE DERIVATIVES, METHODS FOR PREPARING SAME, AND USES THEREOF IN THE TREATMENT OF INSULIN RESISTANCE**

31/497 (2013.01); *A61K 45/06* (2013.01);
C07D 213/74 (2013.01); *C07D 295/088*
(2013.01); *C07D 295/096* (2013.01)

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(58) **Field of Classification Search**
None
See application file for complete search history.

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(56) **References Cited**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **14/128,381**

FOREIGN PATENT DOCUMENTS

(22) PCT Filed: **Jun. 22, 2012**

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WO 0006558 A1 2/2000
WO 02100341 A2 12/2002
WO 03018553 A1 3/2003
WO 2014/095929 * 6/2014

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§ 371 (c)(1),
(2), (4) Date: **Feb. 10, 2014**

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(30) **Foreign Application Priority Data**

Jun. 23, 2011 (FR) 11 55545

(57) **ABSTRACT**

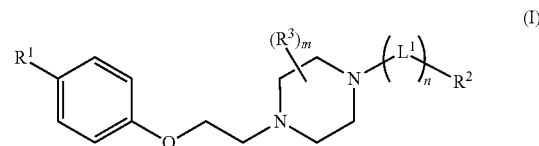
Disclosed herein are compounds and compositions useful in the treatment of pathologies associated with the insulin resistance syndrome (or syndrome X), in particular in the treatment of type 2 diabetes.

(51) **Int. Cl.**

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C07D 295/088 (2006.01)
A61K 31/495 (2006.01)
A61K 31/497 (2006.01)
C07D 295/096 (2006.01)
A61K 45/06 (2006.01)

(52) **U.S. Cl.**

CPC *C07D 241/20* (2013.01); *A61K 31/495*
(2013.01); *A61K 31/496* (2013.01); *A61K*



6 Claims, No Drawings

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PIPERAZINE DERIVATIVES, METHODS FOR PREPARING SAME, AND USES THEREOF IN THE TREATMENT OF INSULIN RESISTANCE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is filed in accordance with 35 U.S.C. §371 and claims benefit of PCT Patent Application Serial No. PCT/EP2012/062143 filed Jun. 22, 2012 and French Patent Application Serial No. 1155545, filed Jun. 23, 2011, both of which are incorporated herein in their entirety by reference.

The present invention concerns novel compounds useful in particular in the treatment of pathologies associated with the insulin resistance syndrome (or syndrome X), in particular in the treatment of type 2 diabetes.

A significant increase in the cases of diabetes in the world has been observed for a few years. Currently there are approximately 250 million diabetics in the world and the predictions for 2030 are around more than 400 million diabetics. Type 1 diabetes (destruction of the cells producing insulin) is mainly treated by the injection of insulin. Type 2 diabetes, which is more widespread (90% of diabetes cases), is characterised by a resistance of the tissues towards insulin and requires special treatment.

Numerous compounds have been proposed for treating diabetes, in particular type 2 diabetes. Piperazine derivatives are known in particular from EP 2781797. Phenylated derivatives are also known from WO 02/100341.

Currently, in approximately 40% of cases, the treatment is not effective and the required glycaemia threshold on an empty stomach of 1.26 g/liter of blood is not achieved.

It is therefore necessary to propose novel compounds affording more effective treatment of the pathologies associated with the insulin resistance syndrome.

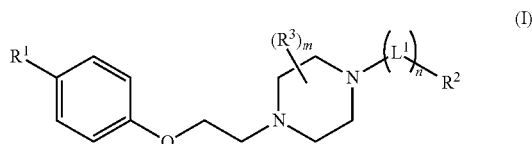
One objective of the present invention is therefore to provide compounds effective in the treatment of the pathologies associated with the insulin resistance syndrome.

Another objective of the present invention is to provide a method for preparing these compounds.

Yet another objective of the present invention is to provide a means of treating pathologies associated with the insulin resistance syndrome, in particular type 2 diabetes. One objective of the present invention is to propose compounds in particular for inhibiting neoglucogenesis.

Yet other objectives will emerge from a reading of the following description of the invention.

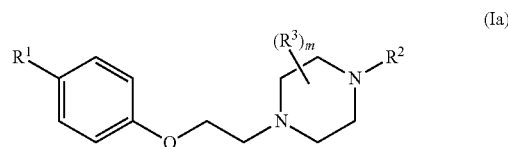
The present invention concerns a compound of formula (I)



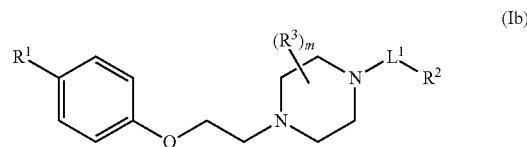
in which n represents 0 or 1, their enantiomers, diastereoisomers thereof and the addition salts thereof with pharmaceutically acceptable bases or acids.

The invention also relates to compounds of formula (I) in which n is 0, which correspond to compounds of formula (Ia), their enantiomers, diastereoisomers thereof and the addition salts thereof with pharmaceutically acceptable bases or acids

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The invention also relates to compounds of formula (I) in which n is 1, which correspond to compounds of formula (Ib), their enantiomers, diastereoisomers thereof and the addition salts thereof with pharmaceutically acceptable bases or acids



In the compounds of formula (I), (Ia) and (Ib) according to the invention:

R¹ represents a —(CH₂)₄C(O)OH group;

n represents 0 or 1;

m represents an integer ranging from 0 to 8;

L¹ represents a —C(O)—; —C(O)O— or —S(O)₂— group;

R² represents:

a carbocycle group with 5, 6 or 7 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a polycarbocycle group with 8 to 14 members, preferably 9 or 10 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a heterocycle group with 5, 6 or 7 members, substituted or non-substituted, saturated, partially unsaturated or aromatic, which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur;

a polyheterocycle group with 8 to 14 members, preferably 9 or 10 members, substituted or non-substituted, saturated, partially unsaturated or aromatic, which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur;

a -L²-carbocycle group, the carbocycle being in 5, 6 or 7 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a -L²-polycarbocycle group, the polycarbocycle being in 8 to 14 members, preferably 9 or 10 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a -L²-heterocycle group, the heterocycle being in 5, 6 or 7 members, substituted or non-substituted, saturated, partially unsaturated or aromatic and which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur;

a -L²-polyheterocycle group, the polyheterocycle being in 8 to 14 members, preferably 9 or 10 members, substituted or non-substituted, saturated, partially unsaturated or aromatic and which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur; or

a hydrocarbon group, linear or branched, C₁ to C₅, preferably C₁ to C₄, preferably alkyl, linear or branched, C₁ to C₅, preferably C₁ to C₄;

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L² being an alkyl, linear or branched, C₁ to C₅, preferably C₁ to C₄;

R³, identical or different, represent:

an alkyl, linear or branched, C₁ to C₅, preferably C₁ to C₄; for example methyl, ethyl, propyl, isopropyl, butyl, tert-butyl;

a -L²-carbocycle group, the carbocycle being in 5, 6 or 7 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a -L²-polycarbocycle, the polycarbocycle being in 8 to 14 members, preferably 9 or 10 members, saturated, partially unsaturated or aromatic, substituted or non-substituted;

a -L²-heterocycle group, the heterocycle being in 5, 6 or 7 members, substituted or non-substituted, saturated, partially unsaturated or aromatic and which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur; or

a -L²-polyheterocycle group, the polyheterocycle being in 8 to 14 members, preferably 9 or 10 members, substituted or non-substituted, saturated, partially unsaturated or aromatic and which may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur.

The carbocycles, polycarbocycles, heterocycles and polyheterocycles are non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;

a halogen atom;

a hydrocarbon group, linear or branched, preferably alkyl, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl, tert-butyl;

a hydrocarbon group, linear or branched, preferably alkyl, C₁ to C₅, preferably C₁ to C₄, substituted in particular by one or more halogen atoms;

a cyano (—CN) group; or

a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

a carbocycle group with 5, 6 or 7 members, saturated, partially unsaturated or aromatic, preferably phenyl, substituted or non-substituted, in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; an alkyl group, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl.

Preferably, in the compound of formula (I), (Ia) and (Ib), R³, identical or different, represent:

an alkyl, linear or branched, C₁ to C₃; or

a -L²-carbocycle group, L² being an alkyl, linear or branched, C₁ to C₅, preferably C₁ to C₄; and the carbocycle being aromatic with 5 or 6 members, for example phenyl, optionally substituted.

Preferably, in the compound of formula (I), (Ia) and (Ib), m represents 0 or 1, preferably 0.

Preferably, in the compound of formula (I), (Ia) and (Ib), R² represents:

a carbocycle group with 6 members, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

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a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;

a halogen atom, for example fluorine, chlorine or bromine;

a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;

a cyano (—CN) group; or

a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);

an aryl group, preferably phenyl, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

a 5 or 6 member aromatic heterocycle group, comprising 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, sulphur and oxygen, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;

a halogen atom, for example fluorine, chlorine or bromine;

a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;

a cyano (—CN) group; or

a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);

an aryl group, preferably phenyl, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

the heterocycle is preferably non-substituted or substituted by a phenyl group, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

an 8 to 14 member aromatic polyheterocycle, preferably 9 to 10 members, comprising 1, 2 or 3 heteroatoms, identical or different, chosen from nitrogen, sulphur and

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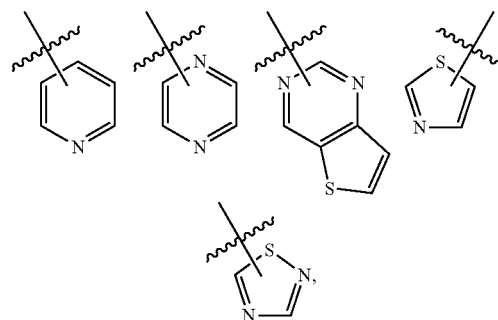
oxygen, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

- a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;
 - a halogen atom, for example fluorine, chlorine or bromine;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;
 - a cyano (—CN) group; or
 - a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);
 - an aryl group, preferably phenyl, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
 - an alkyl group, linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl; or
 - a -L²-carbocycle group, the carbocycle being aromatic with 5 or 6 members, for example phenyl, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:
 - a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;
 - a halogen atom, for example fluorine, chlorine or bromine;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;
 - a cyano (—CN) group; or
 - a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);
 - an aryl group, preferably phenyl, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
- L² being an alkyl group, linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl.

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Preferably, in the compound of formula (I), (Ia) and (Ib), R² represents:

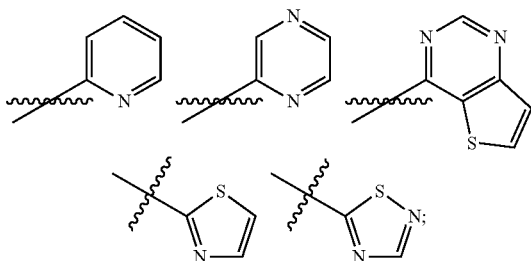
- a phenyl, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:
 - a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;
 - a halogen atom, for example fluorine, chlorine or bromine;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;
 - a cyano (—CN) group; or
 - a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);
 - a phenyl group, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C₁ to C₆ alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C₁ to C₅ alkyl group, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
- preferably the substituent or substituents are in ortho or para position on the phenyl;
- a monocyclic or polycyclic heteroaryl chosen from



- non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:
 - a C₁ to C₆ alkoxy group, preferably C₁ to C₃, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;
 - a halogen atom, for example fluorine, chlorine or bromine;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;
 - a C₁ to C₅ alkyl group, preferably C₁ to C₄, linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;
 - a cyano (—CN) group; or
 - a sulfonylalkyl (—S(O)₂-alkyl) group, in which the alkyl is linear or branched, C₁ to C₅, preferably C₁ to C₄, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane (—S(O)₂CH₃);

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a phenyl group, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C_1 to C_6 alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl; preferably the mono or polycyclic heteroaryl is chosen from



a L^2 -carbocycle group, the carbocycle being a phenyl, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from: a C_1 to C_6 alkoxy group, preferably C_1 to C_3 , linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a halogen atom, for example fluorine, chlorine or bromine; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl; a cyano ($-\text{CN}$) group; or a sulfonylalkyl ($-\text{S}(\text{O})_2$ -alkyl) group, in which the alkyl is linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane ($-\text{S}(\text{O})_2\text{CH}_3$); a phenyl group, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C_1 to C_6 alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

L^2 being an alkyl, linear or branched, C_1 to C_5 , preferably C_1 to C_4 , preferably methyl, ethyl, propyl, butyl, isopropyl, butyl or tert-butyl, for example $-\text{CH}_2-$; or

an alkyl group, linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl.

Preferably, in the compound of formula (I), (Ia) and (Ib), R^2 represents:

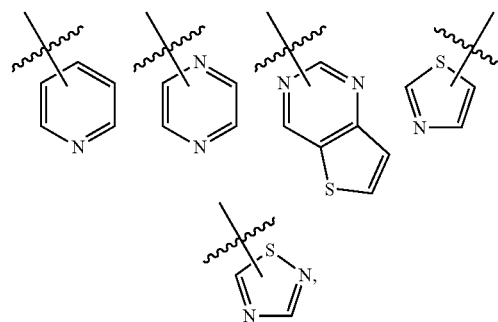
a phenyl, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from: a C_1 to C_6 alkoxy group, preferably C_1 to C_3 , linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a halogen atom, for example fluorine, chlorine or bromine;

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a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl; a cyano ($-\text{CN}$) group; or a sulfonylalkyl ($-\text{S}(\text{O})_2$ -alkyl) group, in which the alkyl is linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane ($-\text{S}(\text{O})_2\text{CH}_3$);

preferably the substituent or substituents are in ortho or para position on the phenyl;

a monocyclic or polycyclic heteroaryl chosen from

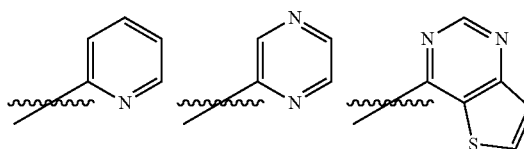


non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

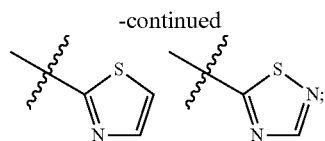
a C_1 to C_6 alkoxy group, preferably C_1 to C_3 , linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a halogen atom, for example fluorine, chlorine or bromine; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl; a cyano ($-\text{CN}$) group; or a sulfonylalkyl ($-\text{S}(\text{O})_2$ -alkyl) group, in which the alkyl is linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane ($-\text{S}(\text{O})_2\text{CH}_3$);

a phenyl group, substituted or non-substituted in particular by one or more substituents, identical or different, in particular chosen from a halogen atom, a C_1 to C_6 alkoxy group, linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy; a C_1 to C_5 alkyl group, preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

preferably the mono or polycyclic heteroaryl is chosen from



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a $-L^2$ -carbocycle group, the carbocycle being a phenyl, non-substituted or substituted by one or more substituents, identical or different, in particular chosen from:

a C_1 to C_6 alkoxy group, preferably C_1 to C_3 , linear or branched, for example methoxy, ethoxy, propoxy, isopropoxy, butoxy or tert-butoxy;

a halogen atom, for example fluorine, chlorine or bromine;

a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl;

a C_1 to C_5 alkyl group, preferably C_1 to C_4 , linear or branched, substituted in particular by one or more halogen atoms, for example trifluoromethyl;

a cyano ($-\text{CN}$) group; or

a sulfonylalkyl ($-\text{S}(\text{O})_2$ -alkyl) group, in which the alkyl is linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl, for example sulfonyl methane ($-\text{S}(\text{O})_2\text{CH}_3$);

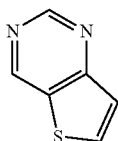
L^2 being an alkyl, linear or branched, C_1 to C_5 , preferably C_1 to C_4 , preferably methyl, ethyl, propyl, butyl, isopropyl, butyl or tert-butyl, for example $-\text{CH}_2-$; or

an alkyl group, linear or branched, C_1 to C_5 , preferably C_1 to C_4 , for example methyl, ethyl, propyl, butyl, isopropyl or tert-butyl.

Polycarbocycle and polyheterocarbocycle according to the invention means carbocycles and polycyclic heterocarbocycles, in particular comprising two merged cycles.

Preferably, unless indicated to the contrary, in the compounds of formula (I), (Ia) and (Ib) according to the invention the polycarbocycles comprise 9 or 10 members and are substituted or non-substituted, preferably comprise 10 members, and are aromatic and substituted or non-substituted.

Preferably, and unless indicated to the contrary, in the compounds of formula (I), (Ia) and (Ib) according to the invention the polyheterocarbocycles comprise 9 or 10 members and may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur, they are substituted or non-substituted, saturated, partially unsaturated or aromatic, preferably aromatic. The polyheterocarbocycles represent in particular

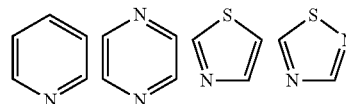


Preferably, and unless indicated to the contrary, in the compounds of formula (I), (Ia) and (Ib) according to the invention the carbocycles comprise 5 or 6 members, are saturated, partially unsaturated or aromatic, substituted or non-substituted, and preferably comprise 6 members and are aromatic, for example phenyl.

Preferably, and unless indicated to the contrary, in the compounds of formula (I), (Ia) and (Ib) according to the invention the heterocarbocycles comprise 5 or 6 members,

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and may comprise 1, 2 or 3 heteroatoms, identical or different, in particular chosen from nitrogen, oxygen or sulphur, they are substituted or non-substituted, saturated, partially unsaturated or aromatic, preferably aromatic. They are for example chosen from



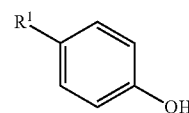
The invention also relates to the solvates of the compounds of formulae (I), (Ia) and (Ib).

The compounds of formulae (I), (Ia) and (Ib) have a carboxylic function and may be salified. They may then be in the form of addition salts with organic or mineral bases. The addition salts with bases are for example pharmaceutically acceptable salts such as sodium salts, potassium salts or calcium salts, which are obtained using corresponding alkaline-metal and alkaline-earth metal hydroxides as bases. As another type of addition salt with pharmaceutically acceptable bases, mention can be made of the salts with amines and in particular glucamine, N-methylglucamine, N,N-dimethylglucamine, ethanolamine, morpholine, N-methylmorpholine or lysine.

The compounds of formulae (I), (Ia) and (Ib) may also be salified with mineral or organic acids and preferably pharmaceutical acids such as hydrochloric, phosphoric, fumaric, citric, oxalic, sulphuric, ascorbic, tartaric, maleic, mandelic, methanesulphonic, lactobionic, gluconic, glucaric, succinic, sulfonic or hydroxypropane sulfonic acids.

The present invention also concerns a first method (P1) for preparing compounds of formula (I), comprising:

(a) the protection of the acid function (carried by R^1) of a compound of formula (II)

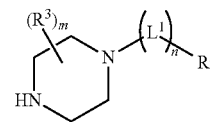


(II)

in which R^1 represents has the definition given for formula (I);

(b) the reaction of the compound obtained at step (a) with a compound of formula $R^4-(\text{CH}_2)_2-R^5$ in which R^4 and R^5 , identical or different, represent a leaving group, preferably R^5 is a better nucleofuge than R^4 ;

(c) the reaction of the compound obtained at step (c) with a compound of formula (III)



(III)

in which L^1 , n , m , R^2 and R^3 have the definitions given by formula (I);

(d) deprotection of the compound obtained at step (c).

The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

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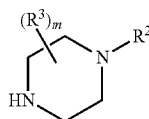
Step (a), corresponding to the protection of the acid function, may be performed in any manner known to persons skilled in the art, provided that the protection is selective of the acid function with respect to the alcohol function. Among the groups protecting the carboxylic function, those generally described in *Protective Groups in Organic Synthesis*, Greene T. W. and Wuts P. G. M, ed. John Wiley and Sons, 1991 and in *Protective Groups*, Kocienski P. J., 1994, Georg Thieme Verlag, may suit. By way of example the protection of the carboxylic function in the ester form (C_1 - C_6 alkyl, for example methyl) can be envisaged. For example step (a) can be performed by reaction of the compound of formula (I) with methanol in the presence of an acid, in particular sulphuric acid.

Step (b) is preferably implemented in an aprotic polar solvent such as acetonitrile, dimethylformamide (DMF), acetone, dimethylsulfoxide and halogenated hydrocarbons such as dichloromethane or dichloroethane, at a suitable temperature, in particular between 15° and 80° C., preferably between 15° and 35° C. A preferred solvent is in particular acetonitrile. Advantageously, this step takes place in the presence of a base such as potassium carbonate. A person skilled in the art knows that a leaving group is all the more labile, the more stable the corresponding anionic species. Thus R^5 being more nucleofuge than R^4 corresponds to the fact that R^{5-} is more stable than R^{4-} . The leaving groups R^4 and R^5 , identical or different, are chosen from the halogen atoms, preferably chlorine and bromine; the (C_6 - C_{10})arylsulfonyloxy groups, the aryl group optionally being substituted by one or more C_1 to C_6 alkyl groups; the (C_1 - C_6)alkylsulfonyloxy groups in which the alkyl group is optionally substituted by one or more halogen atoms. Preferably R^4 represents chlorine and R^5 represents bromine.

Step (c) is a nucleophile substitution step for which the operating conditions can easily be determined by a person skilled in the art. Advantageously, the reaction is implemented in an aprotic polar solvent in the presence of a base. Examples of suitable solvents are acetonitrile, dimethylformamide, acetone, dimethylsulfoxide and the halogenated hydrocarbons such as dichloromethane or dichloroethane. Alkaline or alkaline-earth metal carbonates, for example potassium carbonate, can be mentioned as a base. Advantageously, the reaction of step (c) is conducted at a temperature of 50° to 120° C., for example to reflux of the solvent in the presence of an alkaline metal iodide such as potassium iodide. The quantity of alkaline iodide may be variable and depends essentially on the nature of the reagents, the nature of the solvent and the reaction temperature. The reaction is generally stoichiometric. It is nevertheless possible to work with a slight excess of one or other of the reagents.

The deprotection step (d) may be any deprotection known to persons skilled in the art and compatible with the protection used at step (a) for recovering the acid function. For example, it may be a saponification in basic, acid or catalytic medium (Pd/C).

For preparing the compound of formula (Ia), the same method (P1) applies with the compound of formula (IIIa)

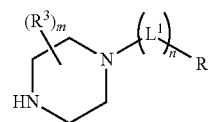


in which R^2 , R^3 and m are as defined for formula (Ia).

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The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

For preparing the compound of formula (Ib), the same method (P1) applies with the compound of formula (IIIb)



(IIIb)

in which L^1 , n , m , R^2 and R^3 have the definitions given by formula (Ib). The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

The invention also concerns a second method (P2) for preparing a compound of formula (I) comprising:

(i) the reaction of a compound of formula (III) with a compound of formula $R^4-(CH_2)_2-R^5$, in which R^4 and R^5 are as defined in the method (P1);

(ii) the protection of the acid function of a compound of formula (II);

(iii) the reaction between the compound obtained at step (i) and the compound obtained at step (ii);

(iv) the deprotection of the compound obtained at step (iii).

The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

Step (i) is preferably implemented in an aprotic polar solvent such as acetonitrile, dimethylformamide (DMF), acetone, dimethylsulfoxide and halogenated hydrocarbons such as dichloromethane or dichloroethane, at a suitable temperature, in particular between 15° and 80° C., preferably between 15° and 35° C. A preferred solvent is in particular acetonitrile. Advantageously, this step takes place in the presence of a base such as potassium carbonate.

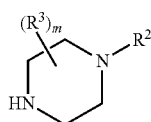
Step (ii), corresponding to the protection of the acid function, may be performed in any manner known to persons skilled in the art, provided that the protection is selective of the acid function with respect to the alcohol function. Among the groups protecting the carboxylic function, those generally described in *Protective Groups in Organic Synthesis*, Greene T. W. and Wuts P. G. M, ed. John Wiley and Sons, 1991 and in *Protective Groups*, Kocienski P. J., 1994, Georg Thieme Verlag, may suit. By way of example the protection of the carboxylic function in the ester form (C_1 - C_6 alkyl, for example methyl) can be envisaged. For example step (a) can be performed by reaction of the compound of formula (I) with methanol in the presence of an acid, in particular sulphuric acid.

Step (iii) is a nucleophile substitution step for which the operating conditions can easily be determined by a person skilled in the art. Advantageously, the reaction is implemented in an aprotic polar solvent in the presence of a base. Examples of suitable solvents are acetonitrile, dimethylformamide, acetone, dimethylsulfoxide and the halogenated hydrocarbons such as dichloromethane or dichloroethane. Alkaline or alkaline-earth metal carbonates, for example potassium carbonate, can be mentioned as a base. Advantageously, the reaction of step (c) is conducted at a temperature of 50° to 120° C., for example to reflux of the solvent in the presence of an alkaline metal iodide such as potassium iodide. The quantity of alkaline iodide may be variable and depends essentially on the nature of the reagents, the nature of the solvent and the reaction temperature. The reaction is generally stoichiometric. It is nevertheless possible to work with a slight excess of one or other of the reagents.

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The deprotection step (iv) may be any deprotection known to persons skilled in the art and compatible with the protection used at step (ii) for recovering the acid function. For example, it may be a saponification in basic, acid or catalytic medium (Pd/C).

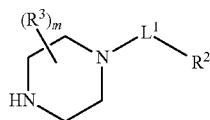
For preparing the compound of formula (Ia), the same method (P2) applies with the compound of formula (IIIa)



in which m, R² and R³ are as defined for formula (Ia).

The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

For preparing the compound of formula (Ib), the same method (P2) applies with the compound of formula (IIIb)



in which L¹, n, m, R² and R³ have the definitions given by formula (Ib).

The starting products are commercial or can easily be prepared by a person skilled in the art on the basis of his general knowledge of organic chemistry.

The compounds of the present invention are useful as medication. They are in particular useful for treating pathologies associated with the insulin-resistance syndrome (or syndrome X), in particular of type 2 diabetes.

The invention also concerns the use of the compounds according to the invention in combination with other treatments, in particular other anti-diabetic treatments.

Advantageously, the compounds of the invention have a strong activity of inhibiting neoglucogenesis.

Advantageously, the compounds of the invention exhibit a glucose consumption activity.

The invention also concerns the use of a compound according to the invention for preparing a medication.

The invention also concerns the use of a compound according to the invention for preparing a medication for treating pathologies associated with the insulin-resistance syndrome (or syndrome X), in particular type 2 diabetes.

The invention also concerns the use of the compounds according to the invention in combination with other treatments, in particular at least one other anti-diabetic agent, for example chosen from insulin, sulfonyl-urea (for example glibenclamide, glimepiride, glipizide), the thiazoline-diones, the glinides, the DPP-IV inhibitor (inhibitor of dipeptidylpeptidase), GLP-1 (Glucagon-like peptide-1) or analogues thereof.

The present invention also concerns pharmaceutical compositions comprising by way of active principle at least one compound according to the invention. These compositions may also comprise a pharmaceutically acceptable vehicle and/or excipient.

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The pharmaceutical compositions may be in any forms known to persons skilled in the art, in particular in the forms intended for administration by parenteral, oral, rectal, percutaneous or percutaneous method, preferably orally.

The compositions according to the invention will be presented in the form of injectable solutes or suspensions or multi-dose flasks, in the form of bare or coated tablets, pills, capsules, powders, suppositories or rectal capsules, solutions or suspensions, for percutaneous use, in a polar solvent, or percutaneous use.

The excipients that are suitable for such administrations are derivatives of cellulose or microcrystalline cellulose, alkaline-earth carbonates, magnesium phosphate, starches, modified starches or lactose for solid forms.

For rectal use, cocoa butter or polyethylene glycol stearates are the preferred excipients.

For parenteral use, water, aqueous solutes, physiological serum and isotonic solutes are the vehicles most conveniently used.

The posology may vary within large limits according to the therapeutic indication and the administration method, as well as the age and weight of the subject.

The invention also concerns a composition comprising, by way of active principle, at least one compound according to the invention in combination with at least one other anti-diabetic agent, for example chosen from insulin, sulfonyl-urea (for example glibenclamide, glimepiride, glipizide), the thiazoline-diones, the glinides, the DPP-IV inhibitor (inhibitor of dipeptidylpeptidase), GLP-1 (Glucagon-like peptide-1) or analogues thereof.

These compositions also comprise a pharmaceutically acceptable vehicle or excipient.

The invention also concerns a method of treating pathologies associated with the insulin-resistance syndrome (or syndrome X), in particular type 2 diabetes, comprising the administration, to the patient who so requires, of a sufficient quantity of at least one compound according to the invention with a pharmaceutically acceptable vehicle or excipient.

The identification of the patient who needs the treatment indicated above is defined by a person skilled in the art. A veterinary or a doctor may identify, by means of clinical tests, physical examination, biological tests or diagnoses and by the family and/or medical history, the subjects who need such a treatment.

Sufficient quantity means a quantity of compound according to the present invention effective for preventing or treating pathological conditions. The sufficient quantity may be determined by a person skilled in the art, by means of conventional technology and by the observation of the results obtained in similar circumstances. To determine the sufficient quantity, various factors must be taken into account by a person skilled in the art, in particular and without being limited thereto: the subject, his size, his age, his general state of health, the illness involved and the degree of severity thereof; the response of the subject, the type of compound, the administration method, the bioavailability of the composition administered, the dosage, the concomitant use of other medications, etc. Preferably, 5 to 500 mg/day of the compound according to the invention is administered to the patient in one or more doses, preferably in one dose.

The present invention also concerns a method of treating pathologies associated with the insulin-resistance syndrome (or syndrome X), in particular type 2 diabetes, comprising the administration, to the patient who needs it, of a sufficient quantity of at least one compound according to the invention with a pharmaceutically acceptable vehicle or excipient and at least one other anti-diabetic agent, for example chosen

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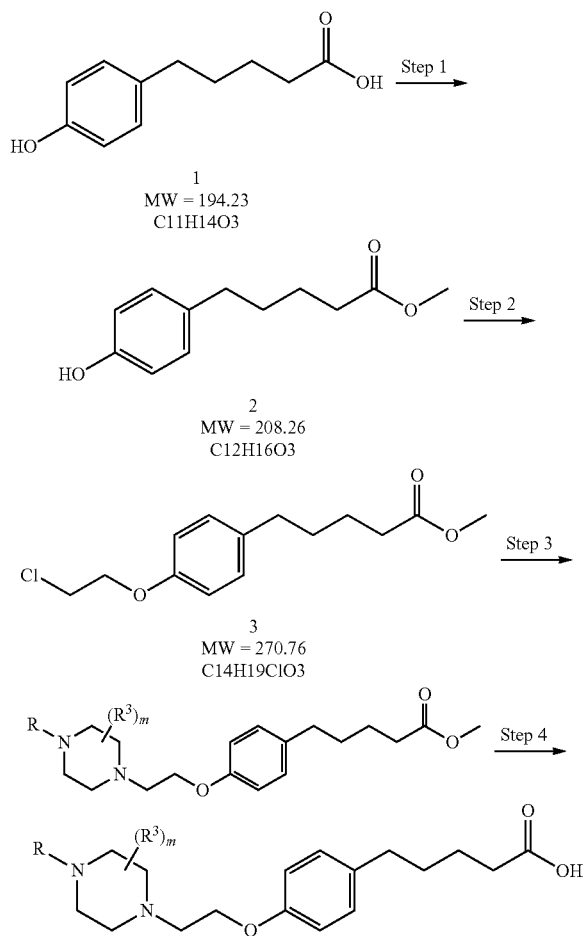
from insulin, sulfonyl-urea (for example glibenclamide, glimepiride, glipizide), the thiazolidine-diones, the glinides, the DPP-IV inhibitor (inhibitor of dipeptidylpeptidase), GLP-1 (Glucagon-like peptide-1) or analogues thereof.

The present invention will now be described with the help of non-limitative examples.

EXAMPLE 1

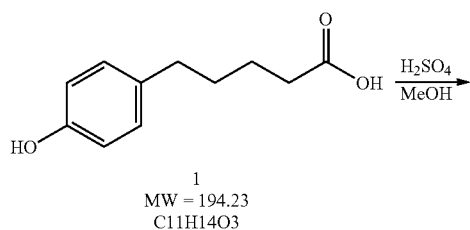
Preparation of Compounds According to the Invention

General Synthesis Diagram



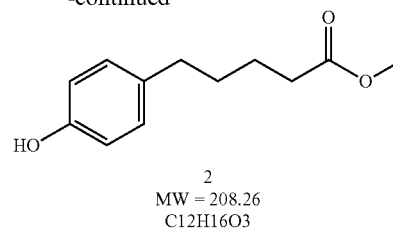
Step 1 is an esterification reaction, steps 2 and 3 are nucleophile substitution reactions and step 4 is a hydrolysis reaction.

Step 1: Esterification



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-continued



Equipment: 500 ml three-necked flask equipped with magnetic agitation and a refrigerant and placed under nitrogen scavenging—Oil bath.

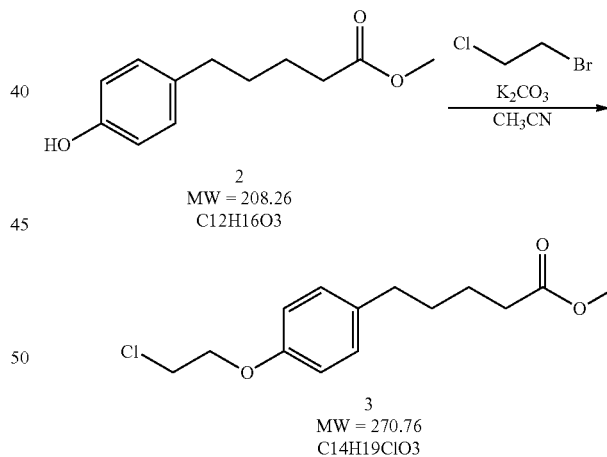
The 5-(4-hydroxyphenyl)-pentanoic acid 1 (25 g) is put in solution in methanol (375 ml) before slowly pouring in a sulphuric acid solution (25 ml). The solution thus obtained is heated at 65°C . for the night.

The advancement of the reaction is monitored by TLC (eluent: heptane/ethyl acetate: 1/1). After a night of agitation under these conditions, the disappearance of the starting acid 1 is observed in favour of a less polar product.

The reaction medium is concentrated dry under reduced pressure. The residue obtained is taken up by dichloromethane (300 ml). The heterogeneous medium is neutralised and basified, carefully, with a saturated sodium hydrogencarbonate solution (pH 8-9). The aqueous phase is then extracted three times with dichloromethane. Once collected together, the organic phases are washed once with a saturated sodium chloride solution, dried on magnesium sulphate, filtered and then concentrated under reduced pressure in order to provide a pinkish oil (27 g).

Yield 99%.

Step 2: Nucleophilic Substitution



Equipment: 500 ml 3-necked flask equipped with magnetic agitation and a refrigerant and placed under nitrogen scavenging—Oil bath.

The methyl 5-(4-hydroxyphenyl)-4-pentanoate 2 (26.8 g) is put in solution in acetonitrile (250 ml). Potassium carbonate (53.36 g), previously dried, is added to the solution. The reaction medium is heated to 50°C . before slowly pouring a solution of 1-bromo-2-chloroethane (55.36 g) into the acetonitrile (60 ml). The reaction medium is heated at 80°C . for the night.

The advancement of the reaction is monitored by TLC (eluent: heptane/ethyl acetate: 7/3). After 24 hours of agita-

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tion under these conditions, the presence of phenol 2 is still observed. An additional quantity of 1-bromo-2-chloroethane (9.23 g, 64.3 mmol, 0.5 eq) is added and the reaction medium is kept under agitation at 80° C. for another 24 hours. The monitoring shows that the reaction does not change. Proton NMR of an aliquot of the reaction medium quantifies the compounds 2 and 3 in a ratio of around 33/66.

After return to ambient temperature, the reaction medium is filtered in order to eliminate the potassium carbonate. The potassium carbonate is rinsed with ethyl acetate and then the filtrate is concentrated dry under reduced pressure. The residue obtained is taken up with water (100 ml) and the aqueous phase is extracted three times by means of ethyl acetate (100 ml). The organic phases are collected together, washed once with a 1 M sodium hydroxide solution (200 ml) and then water (100 ml), dried on magnesium sulphate, filtered and then concentrated under reduced pressure in order to provide a beige oil (39.5 g).

¹H NMR analysis of the raw reaction product reveals the presence of the expected chlorinated derivative 3 in a mixture approximately 30% raw material 2.

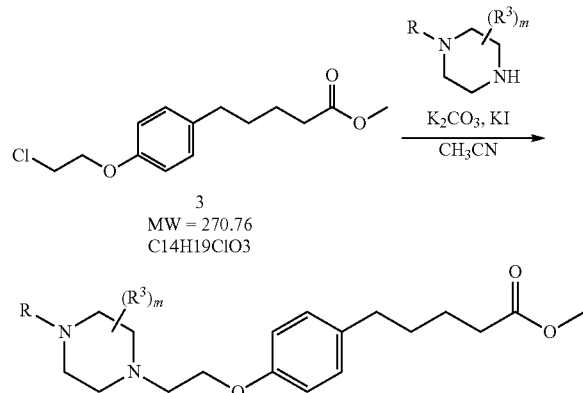
The reaction medium is purified by silica gel chromatography (1 liter).

The compounds to be separated are eluted using a heptane/ethyl acetate gradient.

The required compound is isolated in the form of an oil (22.4 g).

Yield 64%.

Step 3: Nucleophilic Substitution



Equipment: Stem apparatus equipped with a heating system and orbital agitation. 9 ml reactors—Multivac evaporation system—Alexis extraction apparatus.

Under nitrogen scavenging, the chlorinated derivative 3 (500 mg, 1.85 mmol, 1 eq.) is distributed in the various

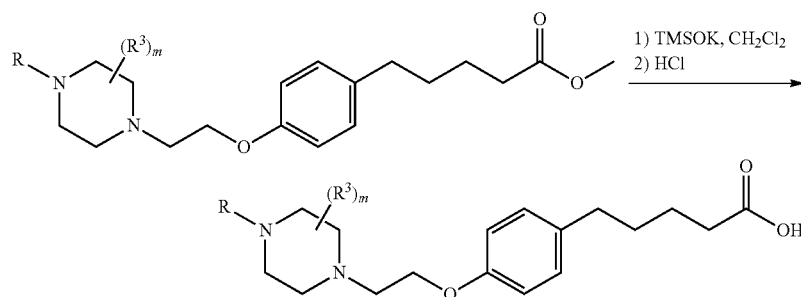
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reactors and then put in solution in acetonitrile (5 ml) in the presence of R-piperazine (1.85 mmol, 1 eq.), potassium carbonate (766 mg, 5.54 mmol, 3 eq.) previously dried, and potassium iodide (307 mg, 1.85 mmol, 1 eq.). After nitrogen scavenging has been carried out, the reactors are closed and heated to 80° C.

After 72 hours, the heating is stopped. After return to ambient temperature, the various reaction media are filtered in parallel on Supelco cartridge connected to a manifold in order to eliminate the inorganic salts. After rinsing with acetonitrile, the filtrates are concentrated dry under reduced pressure using the Multivac. The residues obtained are taken up with water (20 ml) and extracted three times, in parallel on Alexis apparatus, by means of ethyl acetate (10 ml). The various organic phases collected together are dried on magnesium sulphate, filtered and then concentrated under reduced pressure using the Multivac.

The various raw reaction substances are purified by chromatography on Redisep 40 g prepacked column, Biotage SP4 system, using a dichloromethane/methanol gradient.

Step 4: Hydrolysis



Equipment: Stem apparatus equipped with a heating system and orbital agitation, 9 ml reactors—Multivac evaporation system.

The various esters derived from 3 are put in solution in dichloromethane (5 ml) in the presence of potassium trimethylsilanoate. The reaction medium is heated at 35° C. overnight.

After one night of agitation under these conditions, monitoring by TLC (eluent: dichloromethane/methanol, 98/2 UV revelation) makes it possible to verify the disappearance of the esters in favour of more polar products.

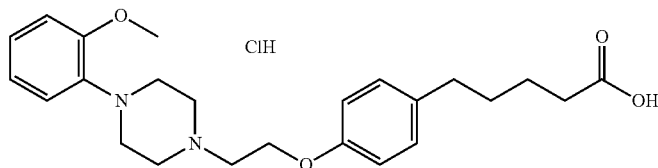
The various reaction media are concentrated dry under reduced pressure. The residues obtained are triturated by means of a mixture of diethyl ether (4 volumes) and ethanol (2 volumes) in order to eliminate the excess potassium trimethylsilanoate and the residual trimethylmethoxysilane. After filtration the potassium carboxylates are isolated and dried under reduced pressure.

Each potassium carboxylate is put in solution in a minimum amount of distilled water (1 to 11 ml) before adding a 1N hydrochloric acid solution (2 eq). After 30 minutes agitation, the acids formed precipitate in the form of a gum. Each acid is regularly triturated until a powdery precipitate appears. The precipitates are filtered, washed once with water and then dried under reduced pressure in the presence of P₂O₅.

The following compounds were obtained by implementation of the method according to the above general diagram.

Yield: 85%

Structure:



Compound 1

Molecular mass: 448.99

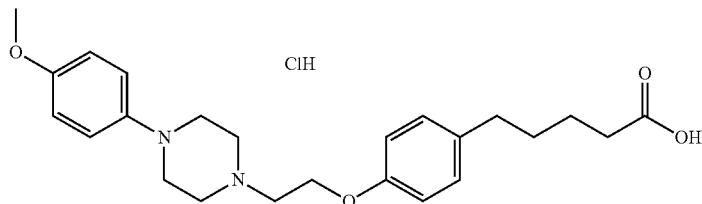
Raw formula: $C_{24}H_{33}ClN_2O_4$

Form/colour: White solid

 1H NMR (MeOD, 300 MHz, δ ppm): 1.47-1.59 (m, 4H); 2.23 (t, 2H); 2.53 (t, 2H); 3.19-3.62 (m, 10H); 3.80 (s, 3H); 4.33 (t, 2H); 6.84-7.04 (m, 6H); 7.09 (d, 2H)
MS (ESI): 413.20 (MH^+); 411.20 (MH^-)

Yield: 80%

Structure:



Compound 2

Molecular mass: 448.99

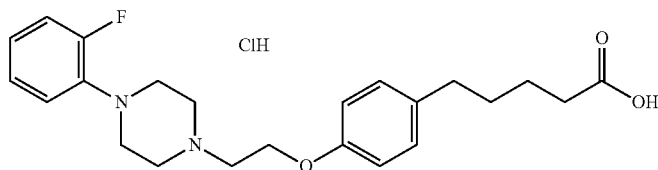
Raw formula: $C_{24}H_{33}ClN_2O_4$

Form/colour: White solid

 1H NMR (MeOD, 300 MHz, δ ppm): 1.60-1.66 (m, 4H); 2.31 (t, 2H); 2.60 (t, 2H); 3.28-3.38 (m, 8H); 3.45 (t, 2H); 3.76 (s, 3H); 4.33 (t, 2H); 6.87-7.02 (m, 6H); 7.16 (d, 2H)
MS (ESI): 413.20 (MH^+); 411.20 (MH^-)

Yield: 76%

Structure:



Compound 3

Molecular mass: 436.96

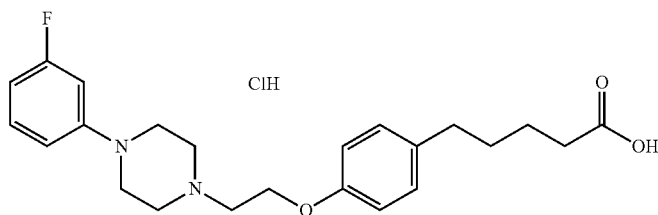
Raw formula: $C_{23}H_{30}ClFN_2O_3$

Form/colour: White solid

 1H NMR (MeOD, 300 MHz, δ ppm): 1.51-1.58 (m, 4H); 2.23 (t, 2H); 2.53 (t, 2H); 3.28-3.38 (m, 4H); 3.47-3.54 (m, 4H); 3.59 (t, 2H); 4.32 (t, 2H); 6.89 (d, 2H); 6.98-7.08 (m, 4H); 7.09 (d, 2H)
MS (ESI): 401.20 (MH^+); 399.30 (MH^-)

Yield: 81%

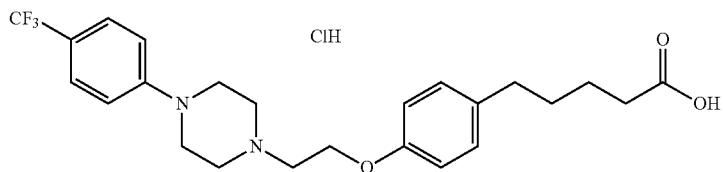
Structure:



-continued

Yield: 74%

Structure:



Compound 8

Molecular mass: 486.97

Raw formula: $C_{24}H_{30}ClF_5N_2O_3$

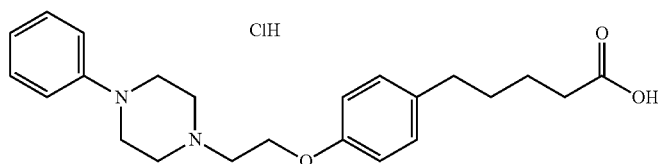
Form/colour: White solid

1H NMR (MeOD, 300 MHz, δ ppm): 1.59-1.66 (m, 4H); 2.31 (t, 2H); 2.61 (t, 2H); 3.40-3.46 (m, 4H); 3.51-3.62 (m, 6H); 4.36 (t, 2H); 6.95 (d, 2H); 7.12-7.18 (m, 4H); 7.56 (d, 2H)

MS (ESI): 451.20 (MH⁺); 449.20 (MH⁻)

Yield: 67%

Structure:



Compound 9

Molecular mass: 418.97

Raw formula: $C_{23}H_{31}ClN_2O_3$

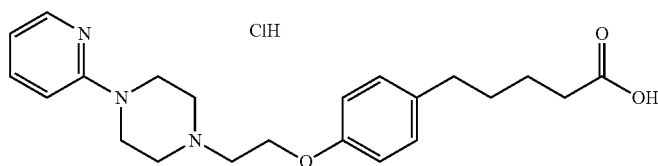
Form/colour: White solid

1H NMR (MeOD, 300 MHz, δ ppm): 1.60-1.65 (m, 4H); 2.30 (t, 2H); 2.59 (t, 2H); 3.03-3.07 (m, 4H); 3.14 (t, 2H); 3.29-3.33 (m, 4H); 4.24 (t, 2H); 6.85-6.92 (m, 3H); 7.01 (d, 2H); 7.13 (d, 2H); 7.24-7.29 (m, 2H)

MS (ESI): 383.20 (MH⁺); 381.20 (MH⁻)

Yield: 68%

Structure:



Compound 10

Molecular mass: 419.96

Raw formula: $C_{22}H_{30}ClN_3O_3$

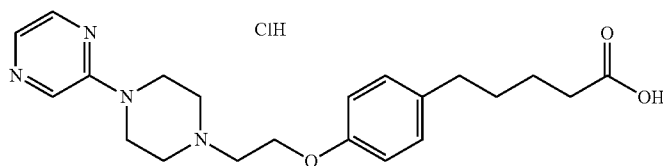
Form/colour: White solid

1H NMR (MeOD, 300 MHz, δ ppm): 1.60-1.65 (m, 4H); 2.30 (t, 2H); 2.59 (t, 2H); 2.97-3.01 (m, 4H); 3.12 (t, 2H); 3.64-3.68 (m, 4H); 4.24 (t, 2H); 6.74 (dd, 1H); 6.88 (dd, 1H); 6.90 (d, 2H); 7.13 (d, 2H); 7.61 (td, 1H); 8.13 (dd, 1H)

MS (ESI): 384.20 (MH⁺)

Yield: 72%

Structure:



Compound 11

Molecular mass: 420.94

Raw formula: C₂₁H₂₉ClN₄O₃

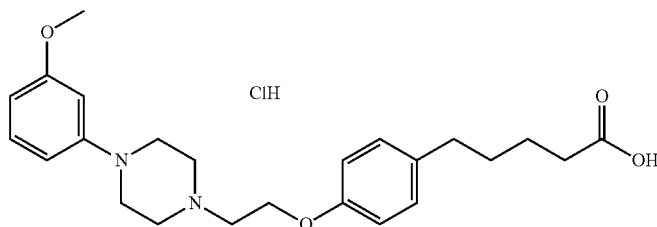
Form/colour: White solid

¹H NMR (MeOD, 300 MHz, δ □ppm): 1.60-1.66 (m, 4H); 2.31 (t, 2H); 2.59 (t, 2H); 2.93-2.97 (m, 4H); 3.08 (t, 2H); 3.74-3.78 (m, 4H); 4.23 (t, 2H); 6.90 (d, 2H); 7.13 (d, 2H); 7.84 (d, 1H); 8.14 (dd, 1H); 8.25 (d, 1H)

MS (ESI): 385.20 (MH⁺); 383.20 (MH⁻)

Yield: 79%

Structure:



Compound 12

Molecular mass: 448.99

Raw formula: C₂₄H₃₃ClN₂O₄

Form/colour: White solid

¹H NMR (MeOD, 300 MHz, δ □ppm): 1.60-1.65 (m, 4H); 2.31 (t, 2H); 2.61 (t, 2H); 3.45-3.59 (m, 8H); 3.67 (t, 2H); 3.78 (t, 3H); 4.40 (t, 2H); 6.54 (dd, 1H); 6.58 (t, 1H); 6.63 (dd, 1H); 6.97 (d, 2H); 7.17 (d, 2H); 7.20 (d, 1H)

MS (ESI): 413.20 (MH⁺); 411.20 (MH⁻)

EXAMPLE 2

Study of the Antidiabetic Activity in db/db Mouse

The antidiabetic activity of the compound of formula (I) orally on a type 2 diabetes animal model, the db/db mouse, was tested.

Diabetic mice are used at the age of 8 weeks; they then have very high hyperglycaemia. The animals are stabilised at a minimum for one week after reception and up to the day of experimentation in an animal house at a temperature regulated at 21°-22° C. and subjected to a fixed cycle of light (from 7 a.m. to 7 p.m.) and darkness (from 7 p.m. to 7 a.m.). Their food consisted of a maintenance regime; water and food were supplied “ad libitum”.

The mice are treated orally with the product to be tested (200 mg/kg per os) in suspension in a mixture of water and methyl cellulose or the vehicle (mixture of water and methyl cellulose) in the morning of the day of the experimentation. Just before the administration of the product and one and two hours after the administration of the product, a blood sample (one drop of blood) is taken following a small incision in the tail for determining glycaemia.

This glycaemia is measured by means of a glucometer (Lifescan OneTouch Ultra, LifeScan, Johnson-Johnson Company) and OneTouch Ultra glycaemia measurement strips.

Table 1 contains the results obtained. These results express the percentage drop in the initial glycaemia. For comparison, the drop in the glycaemia is also reported for control animals that did not receive the vehicle and for metformin.

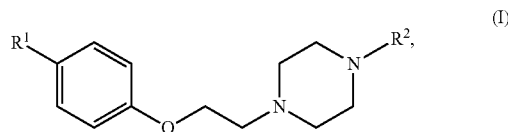
TABLE 1

	Drop in glycaemia (in % of the initial value)	
	After 1 hour	After 2 hours
Control	5	11
Compound 1	34	44
Metformin	22	27

These results show the efficacy of the compounds of formula (I) for causing a reduction in glycaemia in diabetic animals.

The invention claimed is:

1. A compound of formula (I),



in which:

R¹ is —(CH₂)₄C(O)OH; and;

R² represents:

a phenyl, non-substituted or substituted by one or more substituents, identical or different, chosen from:

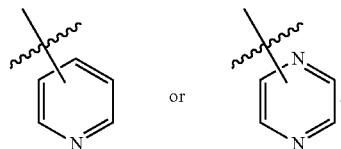
a C₁ to C₆ alkoxy group, linear or branched;

a halogen atom; or

a C₁ to C₅ alkyl group, linear or branched, substituted by one or more halogen atoms;

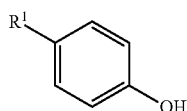
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a monocyclic or polycyclic heteroaryl chosen from



2. A method for preparing a compound according to claim 1, comprising:

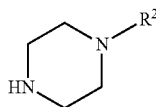
(a) the protection of the acid function of a compound of formula (II)



in which R¹ is as defined by claim 1;

(b) the reaction of the compound obtained at in step (a) with a compound of formula R⁴—(CH₂)₂—R⁵ in which R⁴ and R⁵, identical or different, represent a leaving group;

(c) the reaction of the compound obtained in step (b) with a compound of formula (III)



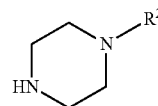
in which R² as defined by claim 1; and

(d) deprotection of the compound obtained in step (c).

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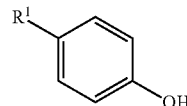
3. A method for preparing a compound according to claim 1, comprising:

(i) the reaction of a compound of formula (III)



in which R² is as defined by claim 1 with a compound of formula R⁴—(CH₂)₂—R⁵, in which R⁴ and R⁵, identical or different, represent a leaving group;

(ii) the protection of the acid function of a compound of formula (II)



in which R¹ is as defined by claim 1;

(iii) the reaction between the compound obtained in step (i) and the compound obtained at step (ii); and

(iv) deprotection of the compound obtained in step (iii).

4. A method for treating type 2 diabetes in a patient in need thereof, the method comprising administering an effective quantity of a compound according to claim 1.

5. A pharmaceutical composition comprising, as active principle, at least one compound according to claim 1.

6. A pharmaceutical composition according to claim 5, further comprising at least one other anti-diabetic agent.

* * * * *